Update on ALPGEN

(new release in ~ 1 week)

Michelangelo Mangano, CERN

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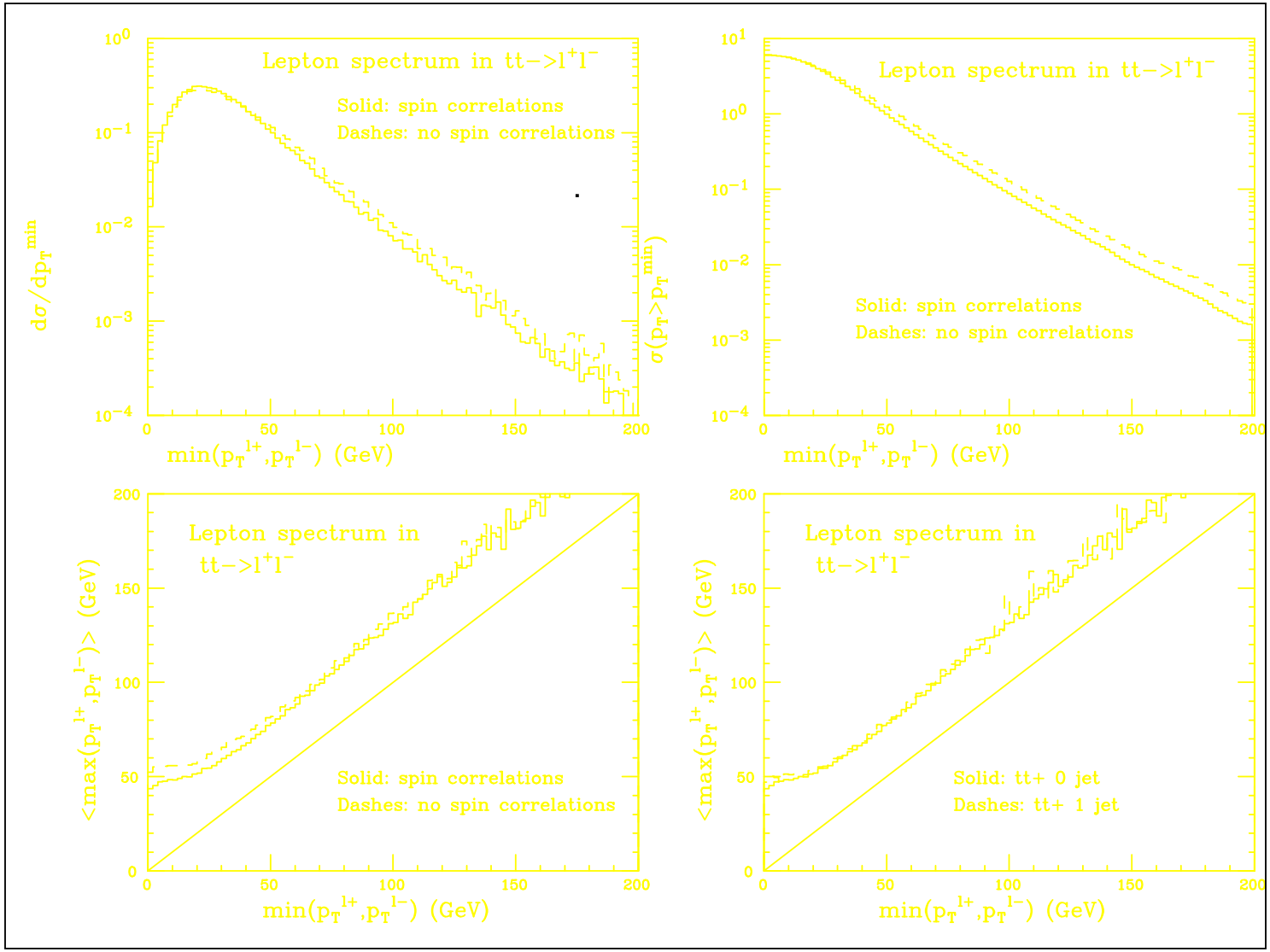
- Description of final states: decays, spin correlations
- Issues of gauge invariance
- Phase space and generation efficiency improvements
- Multijets à la Catani-Kuhn-Krauss-Webber

W decays in WQQ+jets and W+jets

- Allow for selection of W final state during unweighting. No need to generate new samples of weighted events. Select among:
  1. e or or τ
  2. all leptons
  3. all quarks
  4. fully inclusive

Top decays and spin correlations in tt+jets

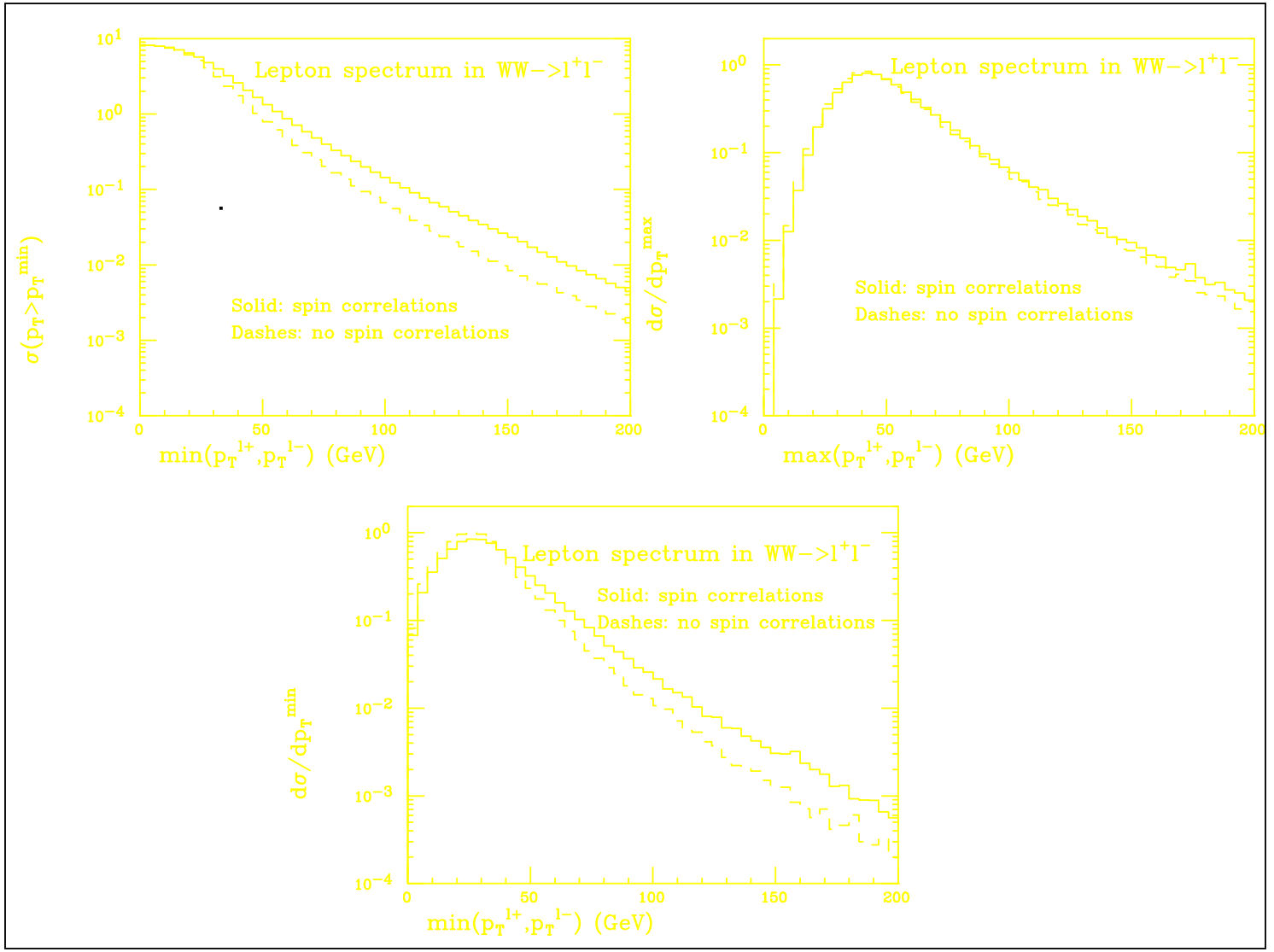
- For each event, generate a t-> b (W -> f fbar') decay, keeping the top and W on-shell
- Use the 3-fermion final state to calculate the top spinorial current to be used in the evaluation of the top matrix element. Spin correlations are then exactly accounted for.
- The information on the 4-momenta of the 3 fermions of each top quark is kept and passed to the user
- This procedure allows to preserve gauge invariance, by working with $\Gamma(top)=0$, and to avoid the inclusion of non-resonant diagrams
- This procedure is implemented for tt+Njets ($N\neq 0$) and for ttH+jets
- All possible final states of the W+W- pair can be selected by the user at the time of unweighting, so that all possible tt final states can be described


Lepton spectrum in tt->l+l-
Solid: spin correlations
Dashes: no spin correlations
dσ/dp_T^min
σ(p_T>p_T^min)
min(p_T l+, p_T l-) (GeV)
Lepton spectrum in tt->l+l-
Solid: spin correlations
Dashes: no spin correlations
min(p_T l+, p_T l-) (GeV)
Lepton spectrum in
tt->l+l-
<max(p_T l+, p_T l-)> (GeV)
Solid: spin correlations
Dashes: no spin correlations
min(p_T l+, p_T l-) (GeV)
Lepton spectrum in
tt->l+l-
<max(p_T l+, p_T l-)> (GeV)
Solid: tt+ 0 jet
Dashes: tt+ 1 jet
min(p_T l+, p_T l-) (GeV)

Multiboson + jets production

- Inclusion of W and Z decays, with exact spin correlations included as in the ttbar case (requires Z final states to be specified before generation). All possible combinations of final states for each W and Z are allowed. W and Z are kept on shell (no virtual photon)
- Gauge invariance requires boson widths in the propagators to be set to 0. This creates problems with resonant channels, such as $W/Z \to q\bar{q}$ or $H \to WW/ZZ$.
- We therefore remove all events with a VB with a propagator mass M_0 such that $|M_0^2 - M^2| < s_0$, with
- $$\int_0^{M^2-s_0} \frac{ds}{(s-M^2)^2} = \int_0^{M^2} \frac{ds}{(s-M^2)^2 + M^2 \square^2}$$

  and $|M_0 - M| < \frac{\square}{\square}$


Lepton spectrum in WW->l+l-
Solid: spin correlations
Dashes: no spin correlations
σ(pT>pT min)
dσ/dpT max
min(pT l+,pT l-) (GeV)
Lepton spectrum in WW->l+l-
Solid: spin correlations
Dashes: no spin correlations
max(pT l+,pT l-) (GeV)
Lepton spectrum in WW->l+l-
Solid: spin correlations
Dashes: no spin correlations
dσ/dpT min
min(pT l+,pT l-) (GeV)

Phase-space/integration/efficiencies...

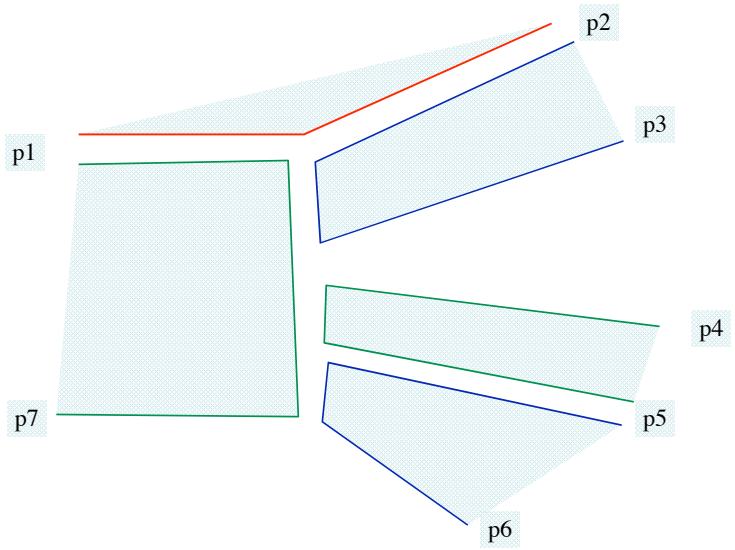
- Introduced average over several colour/spin states in events with large weights. Each event still returns, however, a single colour and spin state (via unweighting)
- Improved phase-space sampling for several processes
- Multi-channelling: introduced a 10% contribution of Rambo-like distributed phase-space points, to suppress diverging Jacobians in corners of phase-space (responsible for very large max weights)
- Overall improvements by factors 2->4 in unweighting efficiencies

CKKW in Alpgen

- Implementing P.Richardson's algorithms in the Alpgen+Herwig interface. S.Mrenna's next
- Need to:
  - develop a more general approach to the clustering, suitable to deal with arbitrary final states
  - develop an alternative to vanilla CKKW, to provide a systematic check of the impact of subleading logs
- Use the fact that Alpgen returns the colour flow as a result of the ME computation. Extract the tree structure of the event by applying the kt algorithm only to colour-connected objects (see next page)
- Should be equivalent to CKKW at the LL and 1/N level
- Hope to have results by the Summer

Example: qg -> q q qbar g g

If Alpgen returns the following colour ordering,



search for minimum kt only among pairs i,j with j=i+1. Iterate for 3-body clusters

$$(p_i + p_{i+1} + p_{i+2})^2$$

etc....

No need to worry about the consistency of the chain of branchings, as this is guaranteed by construction